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Recent Progress on Beam-Breakup Calculations for the Cornell X-Ray ERL

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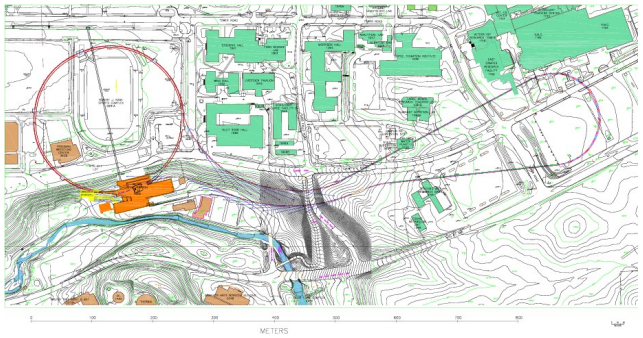
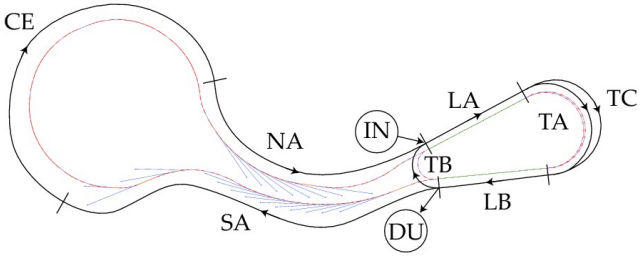
Beam-breakup instabilities arising from the excitation of higher-order modes in the RF cavities are important contributions to the operational current limit in multi-pass linacs.

The tracking calculations of Hoffstaetter, Bazarov and Song (PRST-AB 10, 044401 (2007)) have been generalized for multi-pass ERLs in the Cornell beam physics design and optimization software utility BMAD.
The BBU threshold current calculation has been validated by comparison to analytic approximations in the limits where the HOM decay time is long or short relative to the recirculation time.

Cornell X-Ray ERL



Two-turn ERL under study



Cavity HOM Parameters

	PRSTAB 2007 (TTF)	New 55-55 mm Design
Cornell ERL	12 mA	36 mA
Two-turn ERL	6 mA	8 mA
Cornell ERL (σ_f/f=0.4%)	235 mA	307 mA
Two-turn ERL (σ_f/f=0.4%)	53 mA	87 mA

These new results are consistent with the detailed published results for the Cornell ERL design. The calculations for the two-turn lattice remain under development.

These BBU instability threshold calculations will be an important tool for the optimization of the evolving design of the Cornell ERL X-ray source.
The lattice optics design must depend on fabrication tolerances of the superconducting RF cavities.
Mitigating effects such as the cavity-to-cavity RF frequency spread and the introduction of coupling in the transverse planes will be quantitatively studied.